National Aeronautics and Space Administration

Space Technology

Game Changing Development Highlights

March-April 2014

NASA's Super Guppy delivers "rocket tank of tomorrow"
GCD projects weave fabric of technology's future
SpaceX launch a success: R2 will get its legs!

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NASA unloads composite rocket tank of tomorrow from legendary Super Guppy

—Story and photo credit to Lee Roop and AL.com

HUNTSVILLE, Alabama — The giant rocket fuel tank NASA unloaded Thursday from one of the world's legendary airplanes at Marshall Space Flight Center is a high-stakes bet on the future of space exploration.

"When you build fast and test fast, you can fail fast," admitted John Vickers, NASA project manager for the Composite Cryotank Technology Demonstration to be performed at Marshall this summer. But, Vickers said, "We have very high confidence we're not going to fail the test."

The 18-foot-diameter tank flew to Alabama aboard NASA's legendary Super Guppy, a puffed-up cargo transport that has hauled major pieces of space hardware across the country for decades in various models. This time, the hardware wasn't metal, but a composite-material cylinder 20 feet tall and some 30 percent lighter than an aluminum tank of the same size.

At Marshall, where some of America's unique space assets are located, smaller versions of the tank have already been successfully tested. This one will be lifted into a test stand sometime this summer, filled with 28,000 gallons of dangerous liquid hydrogen rocket fuel and put under pressure to simulate launch pressures.

1) NASA's Super Guppy transport jet on the tarmac at Redstone Military Airfield in Huntsville, Ala. on March 27, 2014. 2) The Super Guppy. 3) Opening the Super Guppy. 4) The composite test tank moves out of NASA's Super Guppy transport. 5) Twin cranes lift the 3,000 pound tank and its support structure from the pallet used to get it out of the Super Guppy. 6) A NASA K-Mag transport tractor waits for the composite tank. The K-Mag, which has 96 wheels, can haul objects up to 800,000 pounds. Cover Photo Credit: NASA.

CRYOTANK

If the structure holds, America's deep space exploration program has taken a significant step. "You'd better being using composites," Vickers said, "because that's where the aerospace is going." Composite structures are already flying, in fact. Boeing used them for 50 percent of the structure of its new 787 Dreamliner, and Boeing built this tank, too.

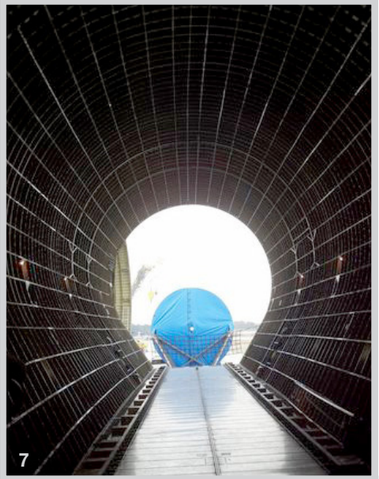
If something goes wrong, that's why the test is at Marshall. The center has safe underground control rooms and big test areas first used to fire Army and Saturn rocket engines.

But before this tank can be tested, it had to be unloaded from the Super Guppy Thursday morning. Marshall's crews have a good reputation for handling rare and expensive space hardware—the mirrors for the James Webb Space Telescope were tested here, for example—but Thursday's crew had its hands full with the gusty wind blowing across the Redstone Arsenal Airfield.

A few knots more wind and the giant cranes wouldn't have been able to work, but the job went off in perfect sequence: slide the tank out of the Guppy's cargo hold on a motorized pallet, use two cranes to lift it above the pallet, drive the pallet away, move a 96-wheel K-Mag tractor capable of hauling 800,000 pounds under the hanging tank, lower the tank and secure it, and drive the tank to a safe and secure location.

So far, so good. Stand by for testing.

Lee Roop is a lifelong Huntsville resident who covers NASA and the HudsonAlpha Institute for Biotechnology.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7) A rare view from inside NASA's Super Guppy jet transport of the composite test tank after being unloaded. 8) A step sign welcomes visitors to the Super Guppy. 9) NASA tank test manager John Vickers shows a model of the composite fuel tank to be tested at NASA Huntsville. 10) A sample of the composite tank material that could result in rocket fuel tanks 30 percent lighter than aluminum. 11) John Vickers, left, NASA manager of the composite tank test, shares a laugh with his industry counterpart, Boeing tank manager Dan Rivera.

ADEPT Carbon Fabric Stitched Seam Test Exceeds Expectations

—Denise M. Stefula

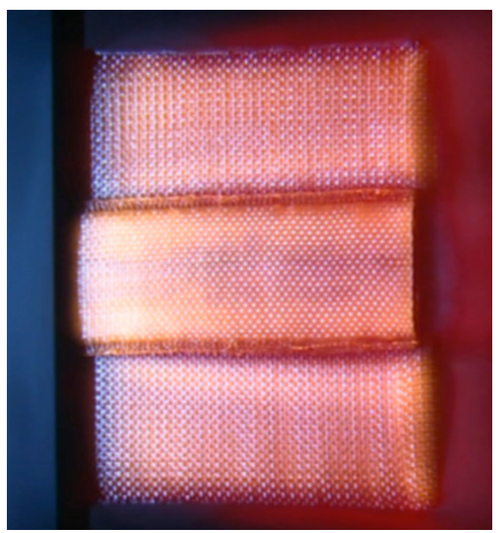
The Adaptable Deployable Entry and Placement Technology (ADEPT) team performed arc jet testing on carbon stitched seams in February 2014 that validated the stitching technique's capability for use in the ADEPT design.

ADEPT, a Space Technology Game Changing Development (GCD) project, develops deployable and material technologies for outer-planet entry, descent and landing applications. The testing was performed to determine the viability of joining the ADEPT carbon fabric with a stitched seam of carbon yarn and then evaluating if the seam would hold its strength when exposed to flight-relevant heating and tension load conditions.

Steve Gaddis, GCD program manager, shared the exciting news with senior leadership: "Test results exceeded the team's expectations…prior to this effort, no one could stitch with carbon yarn and we have now proven that the seam will hold under relevant environmental conditions."

Carbon fiber is inherently brittle and previous attempts to sew with carbon yarn through thick fabric had failed. "Advancements in carbon thread manufacturing, sewing parameter optimization and sewing process tooling enabled this breakthrough," said Alan Cassell, who works with the Entry Systems and Development Branch at Ames Research Center.

Pretest photo of seam test article in large article arc jet test fixture.



Model inserted into 100 W/cm2 flow.

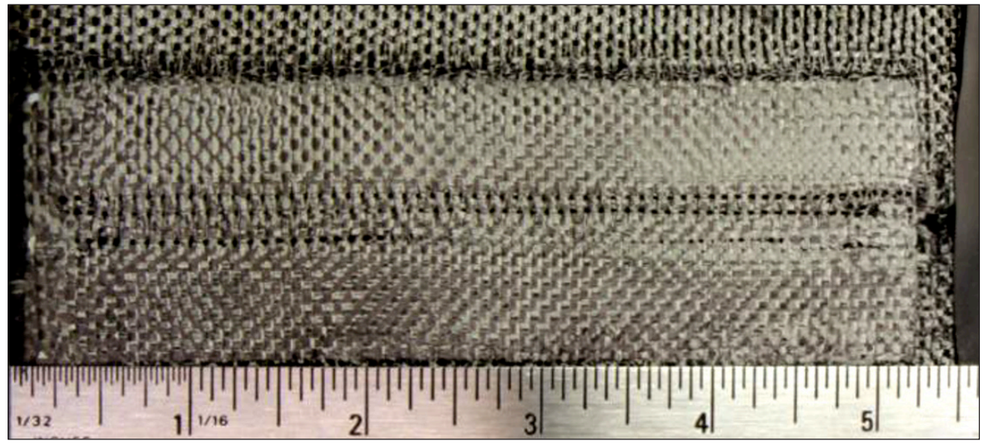
The ADEPT team comprises a complementary mix of materials scientists, mechanical engineers, aerospace engineers and chemists. Industry partners Bally Ribbon Mills (fabric weaving) and Thin Red Line Aerospace (stitching) developed a unique capability as a result of ADEPT needing a solution.

"Both companies have unique capabilities in high performance fabric manufacturing," said Cassell. "Three-dimensional carbon fabric weaving combined with carbon fiber-based stitching could drastically improve the performance of high temperature carbon structures useful in demanding aerospace structural applications."

In addition, the team developed a novel approach to resin infuse the seam to make it even more robust to aerothermal entry environments. The capability opens up options for composite structures and other high temperature structural applications.

The test articles—infused seam samples—were exposed without failure to high tensile loads in excess of 200 lb/in. and aerothermal flow of approximately 100 W/cm^2 for up to 220 s. The samples also sustained heat loads of 20,000 J/cm^2, well above total heat loads expected for the demanding entry environments of future planned missions.

"The test retired the risk of how the yarn would react with high heat rates and whether the seam would hold its strength," said Gaddis. "Based on these results, ADEPT team members can simplify their design and open up their design space for other outer planet mission applications."



Posttest photo of stitched seam exposed to ~12 kJ/cm^2.

A stitch in time saves nine

NASA and its partners find themselves challenged on a regular basis developing new technologies and materials that advance our capabilities to provide fundamental new scientific knowledge, engage a broad segment of the planetary science community, and have wide appeal for the general public whose support enables the program. These new technologies, when patched together, become the fabric of our future.

Regardless the technological advances, when it comes to executing the rigorous testing necessary to gain those advances, planning requires keeping in mind the sage advice from an old adage, one that plays a key role to help researchers and scientists achieve long-standing scientific goals with a suite of new missions across the solar system.

Phrase: A stitch in time saves nine.

Meaning: A timely effort will prevent more work later.

Origin: This has nothing to do with rips in the fabric of the space-time continuum, as some have ingeniously suggested. The question usually asked is "saves nine what"? The 'stitch in time' is simply the sewing up of a small hole or tear in a piece of material, so saving the need for more stitching at a later date when the hole has become larger. Clearly, the first users of this expression were referring to saving nine stitches.

The proverbial expression was clearly meant as an incentive to the lazy. It's especially gratifying that 'a stitch in time saves nine' is an anagram for 'this is meant as incentive'.

—adapted from the "The Phrase Finder" www.phrase.org/uk

HEEET Testing of 3D Woven TPS Reaches Technology Milestone

—Denise M. Stefula

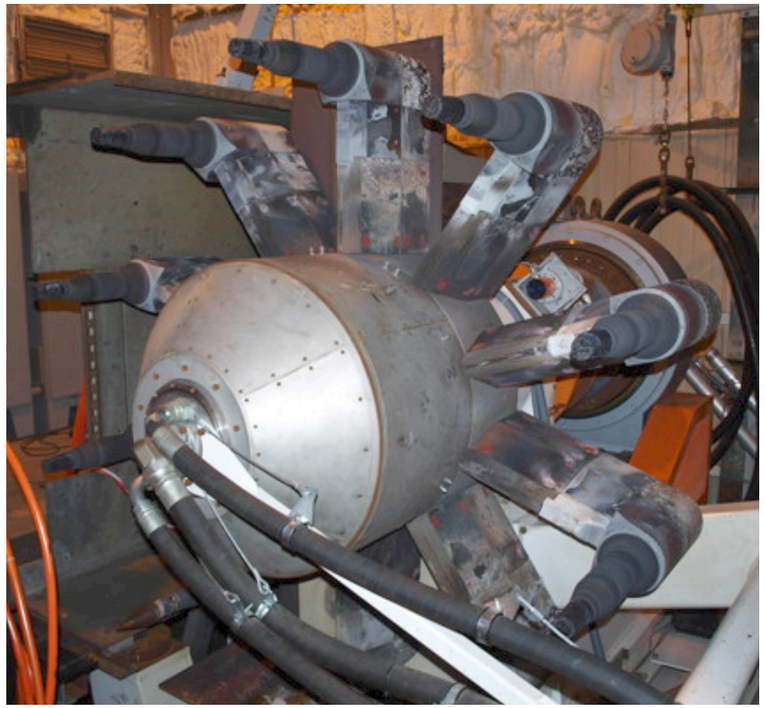
The Heatshield for Extreme Entry Environment Technology (HEEET) project reached a technology milestone in March 2014 during an exploratory test that also validated the feasibility of using the Department of Defense's (DoD) Arnold Engineering Development Center (AEDC) facility at Arnold Air Force Base.

"For HEEET, this test allowed us to assess our TPS at a relevant Venus condition that would never have been possible," said Matt Gasch, principal investigator for the test.

The HEEET project, under NASA's Space Technology Game Changing Development Program, develops woven thermal protection system (TPS) technologies that will provide alternate TPS solutions enabling missions recommended by the NASA Research Council Planetary Science Decadal Survey committee.

Testing at relevant entry conditions allows missions to minimize risk during the entry, descent and landing phase, and the HEEET project's test results indicate its subsystem may be implemented in future missions. Recommended missions include Venus probes and landers, Saturn and Uranus probes, and high-speed sample return operations.

The plan was to examine heritage TPS that was used on the Pioneer Venus missions—carbon phenolic—alongside the 3D woven HEEET material to get a direct comparison of old technology versus new. The team needed a facility capable of evaluating TPS when exposed to extremely high pressures, such as those experienced during entry into Venus' atmosphere.



Seven models protrude from model holders. During the test, the center frame rotates, inserting each model into the flow.

"Because the Ames arc jets were designed more for shuttle-like entry, they are not capable of achieving the high pressure conditions we wanted," said Gasch. "DoD reentry vehicles, however, see very high pressures because they are moving so fast through the atmosphere, thus AEDC was designed to better match higher pressure conditions and looked to be promising for our Venus test case."

With that assurance in place, the next thing to determine was if the AEDC would be a viable option for testing design geometries typical of NASA vehicles because the facility had never before been used to test these particular model types.

The DoD's test articles are normally wedge-shaped or pointed, simulating the side of a ballistic missile or a missile nose. NASA's test articles most frequently have blunt edges because they are designed not to speed through the atmosphere, but to coast through and do science.

"We typically test bigger articles because we want to understand how large sections of our TPS will behave," said Gasch. "Our effort was somewhat exploratory in that the test article design was not something that had really been tested at AEDC."

Along with Mark Smith of AEDC, Gasch and other Ames team members—Dinesh Prabhu, Mairead Stackpoole and Keith Peterson—worked together to do computational fluid dynamics (CFD) modeling and test article design of the AEDC arc jet using a NASA flat-face stagnation model. The CFD allowed the team to estimate testing conditions such as heat flux and pressure, specimen size, and article placement relative to the nozzle exit.

"We knew the conditions we were shooting for and CFD helped us determine the max diameter we could test and still reach those conditions. But beyond that, holder design was a little more exploratory—we couldn't use the existing model holders," said Gasch.

The team pooled its collective design capabilities and attention to detail to further enable the testing conditions, working with Smith to design a new model holder that could take high pressure and high heating. Smith suggested using tape-wrapped carbon phenolic to fabricate holders and additional design measures were implemented to secure the specimen.

"We knew we needed to make sure our sample stayed attached at all times during a test so that led us to a design where we had part of the TPS machined into a tab that fit into the model holder and a titanium pin through the model into the carbon phenolic holder," said Gasch.

Pretest model (top) and posttest model showing frayed and charred fibers.

Finally the moment of truth arrives and all the HEEET team's planning and attention to detail pay off.

"From this test we proved that the HEEET technology can serve as a potential replacement for heritage CP and, in fact, behaves better than the heritage TPS," said Gasch. "HEEET is much more tailorable to different heating conditions so long as the outer recession layer can be maintained and we showed that is possible with our TPS design."

Advancing the technology in tailorable woven TPS will reduce entry loads and significantly reduce heat-shield mass for extreme entry environments missions, and partnering with the AEDC team contributed to the successful test results.

"NASA and DoD partnered together to give the tax payer an excellent return on their investment utilizing personnel and facilities across the country," said Gasch. "The actual test time AEDC offered to NASA free since the test was exploratory. Mark Smith and his team were outstanding.

"With this test we were able to finally verify that testing in stagnation at AEDC is helpful to NASA, something that we've been wondering for several years. This has a huge impact on verification/validation testing for NASA TPS."

University Apparel Design Team Tackles Moisture Management Challenge

—Denise M. Stefula

A five-woman team of students is performing materials research at University of Minnesota to find the best textiles and materials to minimize sweating and move perspiration away from an astronaut's skin, and there's not one engineer in the bunch.

"Our team is made up entirely of women studying functional apparel design," stated Faculty Advisor Lucy Dunne in the team's proposal Non-Powered Moisture Transport Systems for Next-To-Skin Applications.

A space suit's capability to cool an astronaut and control perspiration is not extended to the hand area. The current solution is a tight fitting glove that causes sweat to pool up, which results in skin rashes on the hands and a condition called fingernail delamination, meaning the fingernails fall off.

The Minnesota Women of Functional Apparel Design team plans to draw on its background in textiles and apparel to explore solutions based on materials like wicking textiles, super absorbent materials, and manual pump and valve systems.

During the Spring 2013 Wearable Technologies Symposium, the U of M team elected to attack the 'Moisture Management' problem posed to find novel ways to address moisture buildup in extra-vehicular activity (EVA) gloves. They proposed three unique design solutions last year ranging from changes in basic material selection to a channel and pump system activated by wrist movement.

"The team fabricated a prototype of one of the designs and conducted ground testing to assess its viability," said Lindsay Atchinson, who researches space suit systems at Johnson Space Center. "The results of the initial study, while compelling, weren't able to answer questions as to whether or not similar microchanneling concepts could work in microgravity."

Atchinson then shared with U of M team lead Karen Fiegen information on NASA's Student Flight Opportunities Program, and Fiegen immediately began working with Dunne to submit a proposal to conduct further research as her senior thesis project. Atchinson is mentoring U of M's flight testing activities through the Reduced Gravity Education Flight Program and the investigation will evaluate four different approaches for transferring sweat from the hands up to the vent ducts on the upper inside of the space suit.

Testing results will be included in a technical design library for the high-fidelity EVA glove prototype procurement the Game Changing Development's Next Generation Life Support project is planning for FY15. With the objective to develop high-performance EVA gloves (HPEG), the project seeks to aid glove designers in selecting materials that will work best with current space suit systems and reduce the likelihood of hand injury during EVA training.

Apparel Design studies students Kira Erickson, Mary Ellen Berglund, Karen Fiegen, Crystal Compton and Jordyn Reich in the apparel design studio on the St. Paul campus.

Image credit: U of M's Minnesota Daily.

"This collaboration has been extremely beneficial because the University of Minnesota team brings their novel apparel design background into the mix to find nontraditional solutions that could be implemented relatively easily to meet HPEG objectives of injury reduction through glove system design," said Atchinson.

The U of M team also participates in an ongoing program that is extensively involved in introducing middle school girls to science, technology, engineering and math (STEM) careers through clothing design.

"We believe our approach to applying science and engineering to apparel design can be particularly effective in attracting younger girls to STEM disciplines," said Dunne.

Especially when you get to see students' work going into space—flight testing is scheduled to begin in May of 2014.

What is the "stitch" that holds your team's fabric together?

"The ADEPT team is driven by the passion to see a paradigm shift in the utilization of mass efficient, high performance deployable entry, descent and landing architectures to advance the nation's strategic exploration goals." **—Alan Cassell, Ames Research Center**

"For the HEEET team, it is our 'can do' attitude. The word can't simply isn't in our vocabulary. Everyone is highly motivated and we like to dream big and then make those dreams a reality. The excitement of doing new things, exploring the solar system and solving problems are things that motivate us all." **—Matt Gasch, Ames Research Center**

"Our team is united by a passion for discovery and dedication to the field of functional design and wearable technology." **—Karen Fiegen, team lead, Minnesota Women of Functional Apparel Design, University of Minnesota**

HRS

NASA's R2 Gets Its Groove on Thanks to NRI Grants

—Denise M. Stefula w/ Shonn Everett

The goal of the National Robotics Initiative is to "provide grants to U.S. Universities to conduct research and development in 'co-robotics' … robots that can safely work near people or cooperatively with us," explained Rob Ambrose, NASA's principal investigator for Revolutionary Robotics & Autonomous Systems (RRAS) during a presentation last year. For Space Technology's Game Changing Development project Human Robotic Systems (HRS), that goal is becoming closer, albeit in a "far-out" place.

HRS, a Game Changing Development project, is testing out new technologies that Space Tech funded, in part, through the National Robotics Initiative. The Open Source Robotics Foundation (OSRF) is one of nine organizations receiving grants GCD funded through NRI over the past two years. The partnership with OSRF is for research and development in working to advance "open system robotics architectures and common hardware and software platforms."

With the recently successful SpaceX launch, NASA's humanoid R2 will get its legs, and astronauts already on the space station are scheduled to integrate those legs to the torso in June. Once integrated, R2 will operate while running a combination of open source software products, some of which the OSRF updates and maintains, partially through funding from the NRI grants.

The most commonly known software used in the robotics development community is Robotic Operating System, or ROS. On the ground, at Johnson Space Center, is an identical unit to R2 on which the development team has been running ROS.

"The means to simulate a robot in a zero gravity environment is an area where we see great potential," said Brian Gerkey, OSRF founder and CEO. "Development and testing of robot hardware is already improved because we can now simulate robot behavior and actions prior to having to build the physical robot. In simulation, roboticists have at their fingertips a robust physics engine, realistic sensor generation, high-quality graphics, and convenient programmatic and graphical interfaces."

ROS software is not used on the main R2 unit (consisting of the torso and arms) that already went up to the space station, which was developed some time back and has a unique operating system. When the legs were developed, a new operating system was required to control them. When the legs launched, so too did the new operating system, and the next leg of research is implementation in space.

The R2 development team utilized the open source Robotic Operating System from OSRF as the underlying operating system, the Open Source Computer Vision library for their robotic vision software, and the Open source Robot COntrol Software Real-Time Tookit as their control systems, to decrease the time and cost of developing everything from scratch. (Note: OpenCV and OROCOS were not developed by OSRF.)

"And if you are asking yourself why the legs needed a vision system, the answer is that the gripper feet actually have tiny cameras and 3D sensors in them to aid in guiding them into place," said Shonn Everett, Johnson Space Center. "This is important when the precision is needed to enable them to grip hand rails or lock themselves into chair rail tracks. It's sort of like having an eye in the palm of your hand!"

ROS and other software from OSRF are available to anyone.

"People that develop capability using this environment feed their software back into OSRF providing a wealth of software tools and components that everyone can use," said Ron Diftler, project manager for R2 and exoskeleton research at Johnson Space Center. "R2 is taking advantage of this resource to leverage its own funding in the software area to reduce development time and increase capability."

Software upgrades for the on-orbit R2 unit have been undergoing planning and testing, and once the legs have been installed, they will perform the software upgrade. At that point, the new operating system, of which ROS is a part, will be on the International Space Station.

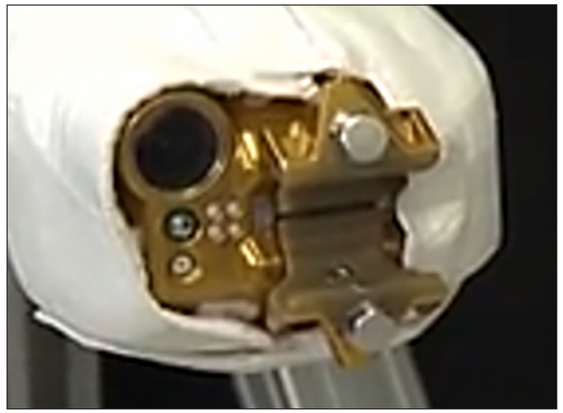


Image: NASA

End effector showing gripper and camera lens.

SpaceX Launches ISS Cargo Flight

The SpaceX Dragon spacecraft launched smoothly Friday, April 18, 2014 aboard the company's Falcon-9 rocket at 3:25 p.m. local time from Cape Canaveral carrying the latest restock cargo for the International Space Station. The SpaceX payload included nearly 2.5 tons of supplies, food, and equipment for science experiments.

Among the research equipment—supporting more than 150 science investigations to be conducted by the space station crew—are a set of legs for Robonaut 2 and hardware for optical communications testing. Advancing the sciences of robotics technology and deep-space optical communications are both areas of research and development supported by STMD's Game Changing Development Program.

The R2 now consists of a head and a torso with two arms and two hands. With the addition of the newly developed climbing legs, the robot can augment its chief role: to help astronauts by taking over some of their duties on the space station.

For the Robonaut team, outfitting the torso with legs is a major milestone.

"We'll go from being the first humanoid robot in space to being the first mobile humanoid robot in space," said Ron Diftler, Robonaut Project Manager within the Robotic Systems Technology Branch at the NASA Johnson Space Center. "Being mobile significantly adds to our capability."

That is, R2's legs will allow it to slowly saunter around the space station. Making use of toe-like fixtures—called "end effectors" that take the place of feet—R2 can use sockets and handrails to move about. With legs, the robot can lend a hand, or two, to the crew while secured to the station by at least one leg.

"Once we are able to go outside the station with an upgraded and more robust R2, then we can start going after some of the more mundane, perhaps dangerous jobs, and help the crew there too," Diftler says.

Image: NASA/Dan Casper

The SpaceX-3 mission soars into the clouds over Space Launch Complex 40 on Cape Canaveral Air Force Station.

In April, Space Tech Mission Directorate Associate Administrator Mike Gazarik toured the Commonwealth Center for Advanced Manufacturing (CCAM) in Richmond, Va. to learn about the structure and research interests at this consortium. NASA was the first government agency to become a member of the applied research center.

From left to right, pictured: David Dress (NASA Langley Research Center Lead for Advanced Manufacturing), Mary Beth Wusk (Game Changing Development Program Integration Manager), David Bowles (Acting Deputy Director for NASA Langley), Michael Gazarik (NASA Associate Administrator for Space Technology Mission Directorate), and Bob Fagan (Chief Technology Officer for CCAM).

NASA Administrator Charles Bolden visited JSC and the Portable Life Support System (PLSS) Ventilation and Development Labs. He was briefed on progress of the Rapid Cycle Amine Swingbed technology and the PLSS 2.0 Integrated Test. The discussion included how technology development bridges programs and directorates, with the example of STMD technology passing to HEOMD's Advanced Exploration Systems Projects. The Suited Manikin Test Apparatus and Ventilation Test Loop and the integrated PLSS 2.0 test article were highlighted during the tour.

A Stellar Win

The Composite Cryotank and Technologies Demonstration team received the Rotary National Award for Space Achievement (RNASA) Foundation "Stellar Award," on April 11, at the annual gala event in Houston, Texas. The RNASA Foundation recognizes those who have made outstanding contributions to the U.S. space programs at its annual awards banquet. CCTD was one of 10 Stellar awards out of over 50 government nominations and over 100 corporate nominations. The CCTD project was nominated by NASA's Glenn Research Center. The RNASA Stellar Awards Evaluation Panel selects the winners from nominations received from industry and government based on whose accomplishments hold the greatest promise for furthering activities in space and the extent to which the nominee meets the goal of recognizing "unsung heroes." Justin Jackson, NASA CCTD project engineer, accepted the award. NASA's Space Launch System also won an award. For more on the award, visit the RNASA website: www.rnasa.org

Stellar Award winners received an engraved marble trophy presented by Astronaut Dr. Karen LuJean Nyberg, and Astronaut Col. (Ret.) Douglas G. Hurley.

April 2014 GCD Employee of the Month

"Within our Game Changing team, members contribute to the STMD mission of 'building, flying, testing' in everything they do. Each month we are recognizing a GCD Employee of the Month, one who embodies the strong STMD 'can do' attitude." –Steve Gaddis, GCD program manager.

Dawn Stewart has been secretary for the GCD program office since September 2011. She supports Program Manager Steve Gaddis directly in administrative tasks, and that support is extended to other managers as well with activities such as travel, meeting planning and documentation, calendar management, and ACES/IT POC.

"I like my job because it's fast paced," said Dawn. "It's dynamic and never gets boring. The people I work with are enthusiastic about developing new technologies and I feel very appreciated for my contributions to the team's success."

"For Dawn, I like to call her Radar," said Steve. "She is always willing to do what needs to be done, and like Radar from the old MASH move, most of the time even before she is asked."

Dawn loves to travel and spend time with her family: husband Greg, 11-year-old daughter Peyton, kitty Lucy and guinea pig Crunch. Her hobbies include music and ancestry/genealogical research.

What is Dawn up to on a weekend? She and Greg like to explore the Civil War battlefields and other historically rich activities in Virginia.

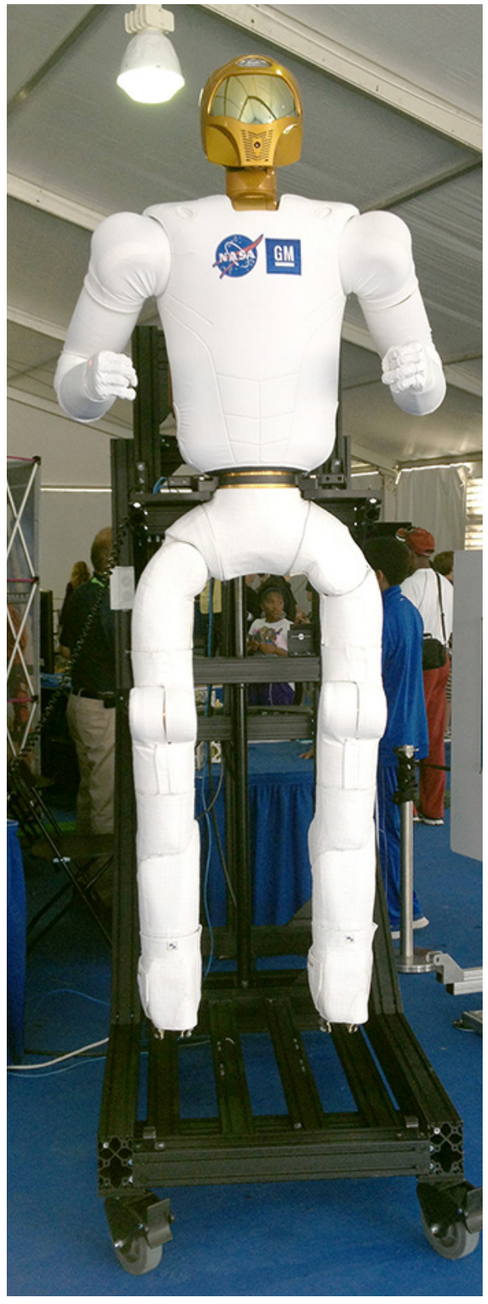
"I love that I can travel within a few hours of home and be in the mountains or at the beach."

Dawn Stewart

Education & Public Outreach

Virginia Senator Updated on Space Tech

Sen. Tim Kaine visited NASA Langley on April 15. This was the senator's first visit to the facility. Kaine spent two hours touring the research center and heard about several technologies and programs at the center. Game Changing Program Manager Steve Gaddis met with Sen. Kaine and gave him an overview of the Space Technology Mission Directorate and Game Changing Development Program. He also discussed current technologies being led at Langley. Here, Gaddis discussed Entry, Descent and Landing (EDL) projects with Sen. Kaine.



R2 with legs demo.

Space Technology Shines at Robot Rocket Rally

More than 15,000 people came through the gates of the Kennedy Visitor Complex the weekend of March 14-16. In addition to all the cool attractions at the complex, visitors got the added bonus of experiencing the first ever Robot Rocket Rally.

By Anna Heiney
NASA's Kennedy Space Center, Fla.

Robots developed by NASA, universities, high schools and private industry showed off their skills with demonstrations and hands-on exhibits during the three-day event, which was designed to raise public awareness and encourage students to consider pursuing careers in the "STEM" fields of science, technology, engineering and math.

Included among the technologies on display were mock-ups of two Space Technology robotic payloads set to fly to the International Space Station aboard the Space Exploration Technologies Falcon 9 rocket.

Holding court in the tent's front and center was a model of the helmeted, futuristic Robonaut 2 (R2) torso. The real thing already is in place on the space station, and a new pair of robotic legs set to launch on SpaceX-3 will add to R2's capabilities. Along with the torso model was a full mock-up of R2, complete with legs like the ones bound for orbit.

"Once (R2) has those legs, it will be able to move from one location to another and start helping the crew with some tasks that the crew really shouldn't have to do: things like cleaning handrails, measuring the airflow, taking inventory," said Ron Diftler, Robonaut project lead.

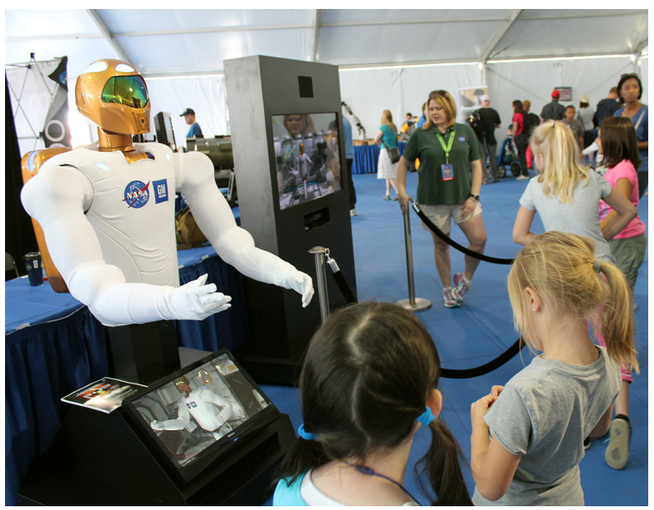
Another NASA technology being prepared for flight on SpaceX-3 is PhoneSat, which is a small satellite. PhoneSat 2.5, a "Cubesat" measuring a mere 10 centimeters by 10 centimeters, is flying as a part of a secondary payload called Educational Launch of Nanosatellites.

Education & Public Outreach

ROBOT ROCKET RALLY

A NASA Johnson engineer demonstrates the X1 Exoskeleton.

GCD communications manager educates children about Robonaut 2 during the rally.



Children and adults took turns playing the interactive R2 Dance game where they had to match their movements to the robot's.

NASA co-op Jennifer Turner and NASA engineer Kody Ensley from Johnson Space Center spent three days interacting with the public and educating them about robots.

Local colleges and universities also participated in the Robot Rocket Rally. Here is a FIRST robot from the University of Central Florida.

Engineers from NASA Johnson held demos throughout the weekend. They discussed the importance of robotics, what R2 does on the ISS and how the legs will be used.

NASA Engineers Spend Day With Pa. Students

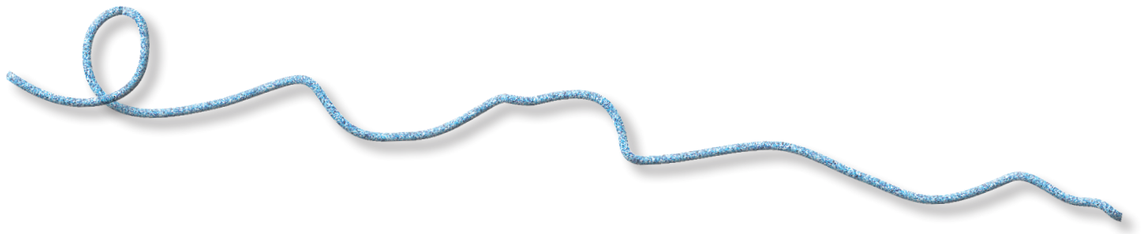
After listening intently during a presentation by NASA engineers on space and NASA's exploration of the solar system, a third-grader asked, "Saturn is a cool place, when are we going to send a probe? Saturn is a gas giant right?"

That was just one of a myriad of questions asked by about 300 elementary students at Oley Valley Middle School recently when NASA Ames engineers Dr. James Arnold and Raj Venkatapathy visited the rural Pennsylvania school for a presentation.

The question reflected not only the success of the presentations and demonstrations given by the engineers, but it also gave Venkatapathy an opportunity to talk about the new heat-shield technology work NASA is doing right down the street from the school.

Oley Valley is located about 30 minutes away from Bally Ribbon Mills, a textile mill where much of the weaving for new heat-shield concepts is taking place. Venkatapathy is the project manager for NASA Space Technology's Woven TPS (thermal protection system) project and works closely with the weavers.

NASA Ames engineers Raj Venkatapathy (above) and Dr. James Arnold (below left) gave presentations and demonstrations to students at Oley Valley Middle School.



Game On!

http://gameon.nasa.gov

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